CLAIMS

1. An azimuth measuring device comprising:

triaxial earth magnetism detecting means for detecting earth magnetism;

output data obtaining means for repeatedly obtaining triaxial output data not smaller than a predetermined number of times, the triaxial output data being obtained from the earth magnetism detecting means at a time when the direction of the earth magnetism detecting means changes in a three dimensional space;

reference point estimating means for estimating, using a statistical method, coordinates of a position where variation of distances from a group of triaxial output data obtained by the output data obtaining means is minimum in a three dimensional space in which the triaxial output data are placed by relating the values of the triaxial output data to the direction components of the respective axes, and for setting the coordinates which are estimated to as a reference point;

offset information calculating means for calculating offset information of output data from the earth magnetism detecting means based on coordinates of the reference point obtained by the reference point estimating means; and

plane determining means for determining whether a group of output data obtained by the output data obtaining means are distributed in the vicinity of a specific plane,

wherein when it is determined by the plane determining means that the group of output data are distributed in the vicinity of the specific plane, the coordinates of the reference point are not estimated by the reference point estimating means, or the coordinates of the reference point estimated by the reference point estimating means are deleted.

2. The azimuth measuring device according to claim 1, whrein the plane determining means makes the determination based on whether a matrix consisted of coefficients of a system of linear equations with the reference points being unknowns is singular or nearly singular.

3. The azimuth measuring device according to claim 1, wherein the plane determining means estimates the specific plane using a group of output data obtained by the output data obtaining means, calculates a correlation between the group of output data and the specific plane, and makes the determination based on whether the correlation is greater than a predetermined value.

4. The azimuth measuring device according to claim 1, wherein the plane determining means makes the determination based on whether a summation of distances is greater than a predetermined value, one of the distances being a distance to the specific plane from a point that is a farthermost

point from the specific plane among the group of output data in one of two domains separated by the specific plane, and the other one of the distances being a distance to the specific plane from a point that is a farthermost point from the specific plane among the group of output data in the other one of the two domains.

5. The azimuth measuring device according to any one of claims 1 to 4 farther comprising warning notice displaying means for displaying a warning notice when the plane determining means determines that the group of output data distributes in the vicinity of the specific plane.

6. An azimuth measuring device comprising:

triaxial earth magnetism detecting means for detecting earth magnetism;

output data obtaining means for repeatedly obtaining triaxial output data not smaller than a predetermined number of times, the triaxial output data being obtained from the earth magnetism detecting means at a time when the direction of the earth magnetism detecting means changes in a three dimensional space;

reference point estimating means for estimating, using a statistical method, coordinates of a position where variation of distances from a group of triaxial output data obtained by the output data obtaining means is minimum in a three dimensional space in which the triaxial output data

are placed by relating the values of the triaxial output data to the direction components of the respective axes, and for setting the coordinates which are estimated to as a reference point;

offset information calculating means for calculating offset information of output data from the earth magnetism detecting means based on coordinates of the reference point obtained by the reference point estimating means;

plane determining means for determining whether a group of triaxial output data obtained by the output data obtaining means are distributed in the vicinity of a specific plane;

plane estimating means for estimating the specific plane using a group of output data obtained by the output data obtaining means, and for setting the specific plane which is estimated as a reference plane;

temporary reference point estimating means for estimating, using a statistical method, coordinates of a position where variation of distances is minimum on the reference plane obtained by the plane estimating means, the distances being those from a group of projected points where a group of triaxial output data obtained by the output data obtaining means are projected on the reference plane, and for setting the coordinates which is estimated as a temporary reference point; and

reference point correcting means for correcting a temporary reference point obtained by the temporary

reference point estimating means, and for setting the temporary reference point which is corrected as a reference point,

wherein when it is determined by the plane determining means that the group of output data are distributed in the vicinity of the specific plane, the reference plane is estimated by the plane determining means; a temporary reference point is estimated by the temporary reference point estimating means; a reference point is calculated by the reference point correcting means; and the offset information calculating means calculates offset information of output data of the earth magnetism detecting means based on coordinates of a reference point calculated by the reference point correcting means.

7. The azimuth measuring device according to claim 6, wherein the plane determining means makes the determination based on whether a matrix consisted of coefficients of a system of linear equations with the reference points being unknowns is singular or nearly singular.

8. The azimuth measuring device according to claim 6, wherein the plane determining means estimates the specific plane using a group of output data obtained by the output data obtaining means, calculates a correlation between the group of output data and the specific plane, and makes the determination based on whether the correlation is greater

than a predetermined value.

9. The azimuth measuring device according to claim 6, wherein the plane determining means makes the determination based on whether a summation of distances is greater than a predetermined value, one of the distances being a distance to the specific plane from a point that is a farthermost point from the specific plane among the group of output data in one of two domains separated by the specific plane, and the other one of the distances being a distance to the specific plane from a point that is a farthermost point from the specific plane among the group of output data in the other one of the two domains.

10. The azimuth measuring device according to any one of claims 6 to 9 farther comprising warning notice displaying means for displaying a warning notice when the plane determining means determines that the group of output data distributes in the vicinity of the specific plane.

11. The azimuth measuring device according to any one of claims 6 to 9, wherein the reference point correcting means sets a closest point to a reference point previously estimated as the reference point on a straight line which passes through the temporary reference point, and which is perpendicular to the reference plane.

12. The azimuth measuring device according to any one of claims 6 to 9, wherein the reference point correcting means estimates a representative value of distances from the group of projected points to the temporary reference point using a statistical method, and sets, as the reference point, a point whose distance from a circle on the reference plane is equal to a predetermined value, the circle having the temporary reference point as the center and the representative value of the distances as the radius.

13. An azimuth measuring device comprising:

triaxial earth magnetsim detecting means for detecting earth magnetism;

output data obtaining means for repeatedly obtaining triaxial output data not smaller than a predetermined number of times, the triaxial output data being obtained from the earth magnetism detecting means at a time when the direction of the earth magnetism detecting means changes in a three dimensional space;

plane estimating means for estimating a plane of which a group of triaxial output data obtained by the output data obtaining means locate in the vicinity, in a three dimensional space in which the triaxial output data are placed by relating the values of the triaxial output data to the direction components of the respective axes, and for setting the plane which is estimated as a reference plane;

temporary reference point estimating means for estimating, using a statistical method, coordinates of a position where variation of distances is minimum on the reference plane obtained by the plane estimating means, the distances being those from a group of projected points where a group of triaxial output data obtained by the output data obtaining means are projected on the reference plane, and for setting the coordinates which is estimated as a temporary reference point;

reference point correcting means for correcting a temporary reference point obtained by the temporary reference point estimating means, and for setting the temporary reference point which is corrected as a reference point; and

offset information calculating means for calculating offset information of output data from the earth magnetism detecting means based on coordinates of the reference point obtained by the reference point correcting means.

14. The azimuth measuring device according to claim 13, wherein the reference point correcting means sets a closest point to a reference point previously estimated as the reference point on a straight line which passes through the temporary reference point, and which is perpendicular to the reference plane.

15. The azimuth measuring device according to claim 13,

wherein the reference point correcting means estimates a representative value of distances from the group of projected points to the temporary reference point using a statistical method, and sets, as the reference point, a point whose distance from a circle on the reference plane is equal to a predetermined value, the circle having the temporary reference point as the center and the representative value of the distances as the radius.